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ABSTRACT

Analysis of reform efforts must include the school as a whole unit, since teachers and policy makers alike face challenges when they try to implement change in the larger context of the school. Four key constructs provide a framework for study of school-level reform: collective action, student experiences in mathematics, equity, and ideal practice. Initial tabulation of data from a survey of 200 schools that were nominated as sites where substantive reform in mathematics education has been achieved showed that 85.9% of teachers indicated strong support for their school's efforts to reform and 88.9% agreed or strongly agreed that the goals and priorities for their school's mathematics courses were clear. More than 31% did not think that mathematics teachers in their school made conscious efforts to coordinate classes or assessment practices. Additional information on the 5-year study can be obtained from the National Center for Research in Mathematical Sciences Education. (MKR)

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SCHOOL-LEVEL REFORM and the TEACHING/LEARNING of MATHEMATICS

ED 370 770

Walter G. Secada and Lisa Byrd

An impressive knowledge base was developed during the last decade that increasingly informs efforts to enhance the teaching of school mathematics. That knowledge base is given visibility in such documents as the NCTM *Standards* (1989, 1991) and the *California Mathematics Framework* (1992), state and national policy initiatives for teacher training and curriculum development, and high school graduation requirements that demand additional mathematics courses of students.

Schools as Units of Analysis

Policy initiatives typically have focused on the nation, state, or district levels, and recent research has been designed to inform policy development at these levels. The research relates the levels to a classroom, a teacher, or a student. Few research efforts have considered a school or a school's mathematics department as a meaningful unit of analysis. In their studies of elementary-school mathematics in California (Prawat, Remillard, Putnam, & Heaton, 1992; Cohen & Ball, 1990), for example, members of the research team from the Elementary Subjects Center focused on how individual teachers interpreted and enacted the mandates of the *California Mathematics Framework* in their classrooms. The school–as an intervening unit–was not included in their analyses.

The work of several researchers provides some excellent ideas of how good teaching or teachers might look under the aegis of reform (Lampert, 1990; Ball, 1993; Fennema, Franke, Carpenter, & Carey, in press). But these analyses do not take into consideration the place where teachers work and where mathematics is taught–the school.

Some work on schools as organizations and on the larger processes of schooling has considered mathematics. Work on tracking (Oakes, Gamoran, & Page, 1992), on effective schools (Good & Brophy, 1986), on school restructuring (Newmann, 1993), on high school departments including mathematics departments (Little & McLaughlin, in press), and on cooperative groups (Cohen, 1992) provides insight on how schools are organized and how their organization and operation affect the teaching and learning of mathematics. The mathematics content that is taught and how the quality of that content may constrain the teaching/learning process typically have not been considered.

There are sound reasons why researchers should be concerned about the school as a site for enhancing the teaching of mathematics. Teachers and policy makers alike face challenges when they try to implement change in the larger context of the school. Unless efforts to improve mathematics teaching are understood in settings that are more expansive than an individual teacher's classroom, these challenges will not be understood. Curriculum development efforts, for example, often rely on individual-teacher volunteers to test materials. School-wide efforts to adopt changes or test new materials seldom take place. Without an understanding of how materials are treated within a school and related issues such as cross-grade articulation and within-school variability in adoption, it is unlikely that the full effects of the preliminary curricula will become apparent. Suppose a class were to receive outstanding mathematics instruction on worthwhile content for a year during its schooling. Would the class be returned to instruction-(business)-as-usual after that year? Or would the school make programmatic or school-level efforts to ensure continuity across several grade levels?

The preceding paragraphs define the issues that inform the research efforts of the Working Group on The Implementation of Reform at the National Center for Research in Mathematical Sciences Education. Their study of school-level reform is focused at the intersection of two major lines of research: improving the teaching and learning of mathematics, and the restructuring and reorganization of schools.

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Framework for the Study of School-Level Reform

Four key constructs provide the framework used by Working Group staff members for their study of school-level reform. The constructs are derived from multiple fields of inquiry: effective schools, school restructuring and organization, and teachers' professional lives. Mathematics is viewed as one of many aspects of the study set within the larger environment of schools. The key constructs of the framework are collective action, student experiences in mathematics, equity, and ideal practice.

Collective action

This study distinguishes between collective action and the work of the individual teacher who endeavors to enhance the mathematics learning of his or her students, but who often works in isolation, without the support of the collective efforts of a group of teachers or a program, department, or school. The construct, collective action, is used to convey the notion that the school, or some significant unit of it, may adopt a particular mission. In this case, the mission would be the enhancement of mathematics teaching and learning. The school or a unit of it may then take concerted, coordinated actions to achieve a particular mission.

Student experiences in mathematics

The second key construct, student experiences in mathematics, refers to the constellation that students may experience in school mathematics that: (a) supports reasoning, (b) contains worthwhile content, and (c) forms a coherent whole. Aspects of these experiences include the curriculum, the teaching and assessment students encounter, the technologies and other tools students use, the oral and written communication in mathematics that students take part in, the locus of mathematical authority in students' classrooms, the attention given to student beliefs about and attitudes toward mathematics, and the access to mathematics courses provided all students. The construct, student experiences in mathematics, is used to obtain information about the importance of connections both across disciplines and within mathematics, of cross-grade coherence and program articulation, and of the gestalt–how students experience mathematics as a discipline and as an entity that is dynamic and useful to them.

Equity

Equity is used in the study to refer to the range of concerns and actions that schools, teachers, and districts take when they act on the belief that all students–regardless of race, gender, social class, or language ability–can learn mathematics. It includes educational opportunity (to learn mathematics) and educational achievement (in mathematics). Are there, for example, systemic, school-wide efforts to ensure that diverse student populations are encouraged to take mathematics and that their experiences in mathematics are worthwhile? The research seeks knowledge about how schools construe equity in mathematics education and how they act upon that meaning.

The study is designed to provide an understanding of how each of the constructs; collective action, student experiences in mathematics, and equity are constituted and interact at a school. What are the parameters, for example, of (a) collective action, (b) student experiences in mathematics, and (c) equity at a given school? How did each of these parameters develop over time? What trade-offs took place during their development? How are the parameters maintained and nourished? What are the obstacles that had to be overcome? How are the various parameters related within and across the major constructs?

. . .the study of reform seeks information about how ideal practice gets translated into school-wide practice.

Ideal practice

Documents such as the *Standards* (NCTM, 1989, 1991), represent ideal practice. Other visions of ideal practice can be derived from work on learning with understanding (Hiebert & Carpenter, 1992), constructivist prescriptions for teaching (Davis, Maher, & Noddings, 1990), teaching as a profession (Lieberman, 1988), reflective teachers (Zeichner, in press), and other theoretical analyses of teaching. Descriptions of ideal practice are being derived for the key constructs.

Finally, the study of reform seeks information about how ideal practice gets translated into school-wide practice. An ideal seldom is encountered in actual contexts. Substantial variability occurs in actual contexts because of the constraints imposed by the competing forces of school

environments. Schools, in addition, may choose to pursue different avenues for reform or focus on different issues. They may also be at different points in their development of reform activities. Hence, in order to implement practices that move in the direction of reform, most schools make trade-offs.

The constructs of collective action, student experiences, equity, and ideal practice with its variability, provide structure to this study of reform. They are also useful guides in a search for schools whose efforts to enhance mathematics programs are substantive. Each of the constructs has multiple dimensions that will undergo further elaboration. Schools may find this beginning framework useful as they begin or increase their efforts to implement reform. They will need to consider balancing their efforts and resources in an optimal way as they change their mathematics programs. While schools may find it necessary to make trade-offs in the process of seeking ideal practice, they should be conscious of the impact of the trade-offs that relate to the four constructs.

Some Initial Results

A series of survey forms and structured interview formats were developed to collect research data from the sample of schools that were nominated as sites where substantive reform in mathematics education has been achieved. Both the survey form designed for a school's teachers and that designed for a key informant include questions that relate to the four constructs. Individual questions are worded in nonjudgmental ways to avoid eliciting responses based on social desirability. Some questions were included on both teacher and key-informant survey forms. The answers to the questions that the two forms have in common permit researchers to reach–by triangulation–a perception of the school's efforts. Brief written descriptions of a school's efforts to improve its mathematics program provided additional support for the school-wide perceptions.

Initial tabulation of data from 200 schools includes responses from 715 teachers: 85.9 percent of teachers in these schools indicated strong support for their school's efforts to reform its mathematics program. When asked whether the goals and priorities for their school's mathematics courses were clear, 38.6 percent of teachers strongly agreed and 50.3 percent agreed. More than 31 percent of teachers did not think that mathematics teachers in their school made conscious efforts to coordinate assessment practices or the manner in which they structured and taught their mathematics classes. The largest percentage of teachers preferred planning sessions devoted to the coordination of content that also suggested materials and activities to guide instruction. Secondary analyses revealed high school mathematics teachers do more team teaching and collaborative planning for curriculum and assessment than do their elementary and middle school colleagues. The initial results are taken from an extensive data summary prepared for the 200 schools in March 1993. Additional information on the 5-year study can be obtained from Dr. Walter Secada, National Center for Research in Mathematical Sciences Education, University of Wisconsin-Madison, 1025 W Johnson Street, Madison, WI 53706.

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